PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-233543
(43)Date of publication of application : 13.09.1996

(51)Int.CI. G01B 11/16
G01R 31/00

(21)Application number : 07-039699
(22)Date of filing : 28.02.1995

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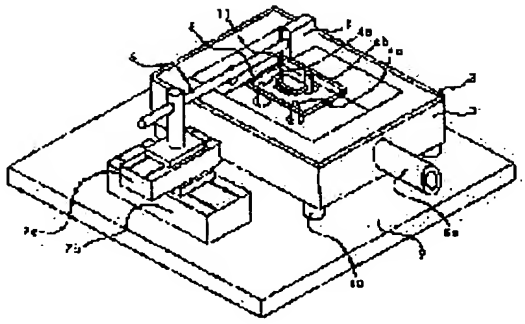
(54) THERMAL DEFORMATION MEASURING APPARATUS

(57)Abstract:
PURPOSE: To simply and accurately measure the two-dimensional out-of-surface thermal deformation of an article.
CONSTITUTION: The thermal deformation measuring apparatus comprises a thermostatic chamber 2 for varying the temperature of a sample 11, means for measuring the deformation of the sample 11, and a controller for controlling the measurement of the deformation and the temperature of the chamber. The upper surface of the chamber 2 is covered with a transparent plate 3. An optical non-contact displacement meter 1 is provided above the plate 3. The meter 1 is scanned in a two-dimensional plane, the distance between the sample provided in the chamber 2 and the meter 1 is sequentially measured, and the measured results are recorded in a memory provided in the controller.



LEGAL STATUS

[Date of request for examination]	13.12.2001
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3608241
[Date of registration]	22.10.2004
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's	

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CLAIMS

[Claim(s)]
[Claim 1] In the heat deformation measuring device possessing the thermostat for changing the temperature of a sample, a means to measure deformation of a sample, and the control unit that controls deformation measurement and thermostat temperature The heat deformation measuring device characterized by what is recorded on the storage in which the distance between the sample which was wearing the top face of a thermostat with the transparence plate, formed the displacement gage non-contact [optical] above this transparence plate, scanned this displacement gage in the two-dimensional flat surface, and was prepared in the thermostat, and this displacement gage was measured serially, and the measurement result was prepared in this control unit.
[Claim 2] The heat deformation measuring device characterized by performing point to point control of this stage by the digital control method with this control device in a heat deformation measuring device according to claim 1 as a means which scans this displacement gage using the screw-thread type stage of a pulse motor drive.
[Claim 3] The heat deformation measuring device characterized by making a hole in the base of this thermostat, fixing the lower limit of through and this supporter material to a surface plate for the supporter material from which coefficient of linear expansion was made from the ingredient 1 ppm [/degree C] or less by this hole in a heat deformation measuring device according to claim 1, and supporting a sample by the upper limit of this supporter material.
[Claim 4] The heat deformation measuring device characterized by performing a temperature setup of a sample by sending into this thermostat the air which carried out the temperature control with the heating cooling system in a heat deformation measuring device according to claim 1.
[Claim 5] The heat deformation measuring device characterized by calculating the amount of displacement of a sample by memorizing the measurement data of the distance between a sample and this displacement gage in the scan of the same specification performed twice or more to this store in a heat deformation measuring device according to claim 1, and calculating the difference of 2 sets of these data of arbitration.
[Claim 6] The heat deformation measuring device characterized by using the displacement gage by the approach of measuring the distance between a sample and a displacement gage by making a sample reflect the laser beam generated with the semiconductor laser generating component in a heat deformation measuring device according to claim 1, and detecting the location of the reflected light by the semi-conductor location sensor.
[Claim 7] The heat deformation measuring device which suspends the scan of this displacement gage, is made to carry out time amount quiescence and is characterized by the fixed thing for which distance between a sample and this displacement gage is measured after that in a heat deformation measuring device according to claim 2 in case the distance between a sample and this displacement gage is measured.
[Claim 8] The heat deformation measuring device characterized by performing the roll control of **** which cancels the backlash of the screw thread of a **** type stage at any time in a heat deformation measuring device according to claim 2.
[Claim 9] The heat deformation measuring device characterized by moving this displacement gage only 1 round along the perimeter of measuring range in advance of displacement measurement in a heat deformation measuring device according to claim 2.
[Claim 10] The heat deformation measuring device characterized by constituting this supporter material from three quartz rods, laying a quartz plate in these three supporter material upper limit in a heat deformation measuring device according to claim 3, and laying a sample on this quartz plate.
[Claim 11] The heat deformation measuring device characterized by calculating the heat deformation of a

sample by changing the temperature of a sample, performing the scan of the same specification twice or more in a heat deformation measuring device according to claim 5, and calculating the difference of 2 sets of these data of arbitration.

[Claim 12] The heat deformation measuring device characterized by adding the function which displays the amount of displacement of a sample on a display unit to this control unit in a heat deformation measuring device according to claim 5.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] It is suitable for especially measuring especially heat deformation of electronic parts about the suitable heat deformation measuring device for this invention to relate to the equipment which measures the heat deformation outside an objective field, especially measure two-dimensional distribution of ****** deformation of a body.
[0002]
[Description of the Prior Art] Electronic parts, such as a semiconductor device, have structure which carried out the laminating of the tabular member from which coefficient of linear expansion differs fundamentally. For this reason, if the temperature change of such electronic parts is added, components will carry out out-of-plane deformation according to the bimetal effectiveness, and curvature will arise. Consequently, stress may join a part for the configuration member of electronic parts, or a joint, and destruction may arise. Thus, in development of electronic parts, the consideration to heat deformation is important, and in order to perform selection of the ingredient to be used, and evaluation of electronic parts made as an experiment, the measuring device of heat deformation is needed.
[0003] The approach of measuring heat deformation of data is indicated by JP,1-237476,A by applying and heating a needle as a measuring method of heat deformation of electronic parts in the sample which it is going to measure, and measuring the variation rate of the needle of the opposite side.
[0004] the measuring method according to a moire method as a measuring method of heat deformation of another electronic parts -- 41st electro nick KOMPONENTSU and -- Technology It is indicated by the 387th page (Proceedings of 41st Electronic Componentsand Technology Conference, (1991), pp 382-387) from the 382nd page of pro C DINGUZU (1991) of a conference.
[0005]
[Problem(s) to be Solved by the Invention] The approach of a contact process using a needle can measure only one point fundamentally among the above-mentioned conventional techniques. If the number of needles is increased, although the variation rate of two or more points can be measured, the number has the fault that it is limited naturally and the variation rate of two or more points which crowded cannot be measured. Especially as mentioned above, since curvature becomes a problem in many cases, it needs to get to know the variation rate of two or more continuous points, and to this purpose, as for heat deformation of electronic parts, this approach is unsuitable.
[0006] Since the variation rate of the arbitration of the field to measure can be measured and two-dimensional information is acquired, the heat deformation measuring method by the moire method agrees for the above-mentioned purpose. However, since this approach uses the interference fringe of light, it needs a special technique for data processing for evaluating a variation rate, and there is a problem also in the accuracy of measurement. Furthermore, the range of the variation rate which can be measured is also small.
[0007] Especially this invention aims at offering the equipment which measures two-dimensional distribution of ****** deformation of the body centering on electronic parts with a sufficient precision simple.
[0008]
[Means for Solving the Problem] The thermostat for heat deformation assumption equipment changing the temperature of a sample, in order to attain the above-mentioned purpose, It constitutes from a means to measure deformation of a sample, and a control unit which controls deformation measurement and thermostat temperature. The distance between the sample which was wearing the top face of a thermostat with the transparence plate, formed the displacement gage non-contact [optical] above this transparence

plate, scanned this displacement gage in the two-dimensional flat surface, and was prepared in the thermostat, and this displacement gage is measured serially, and it is attained by recording on the storage in which the measurement result was prepared in this control unit.
[0009] It is effective to perform point to point control of this stage by the digital control method with a control device as a means which scans a displacement gage using the screw-thread type stage of a pulse motor drive. As a measuring method of a variation rate, in case the distance between a sample and this displacement gage is measured, the scan of this displacement gage is suspended. The fixed thing for which time amount quiescence is carried out and distance between a sample and this displacement gage is measured after that, It is effective to move this displacement gage only 1 round along the perimeter of measuring range in advance of to perform the roll control of **** which cancels the backlash of the screw thread of a screw-thread type stage at any time, and displacement measurement.
[0010] Furthermore, the accuracy of measurement can be raised by making a hole in the base of a thermostat, fixing the lower limit of through and supporter material to a surface plate for the supporter material from which coefficient of linear expansion was made from the ingredient 1 ppm [/degree C] or less by this hole, and supporting a sample by the upper limit of supporter material. It is desirable to constitute this supporter material from three quartz rods, to lay a quartz plate in these three supporter material upper limit, and to lay a sample on this quartz plate.
[0011] Moreover, it is desirable to perform a temperature setup of a sample by sending into a thermostat the hot air heated with the hot blast generator (heating cooling system) (temperature control) as the heating approach of a sample. As for cooling, it is desirable to carry out by sending into a thermostat the air cooled with the refrigerator.
[0012] By memorizing the data of the distance between the sample in the scan of the same specification performed twice or more, and this displacement gage to this store in the heat deformation measuring device by this invention, and calculating the difference of 2 sets of these data of arbitration The amount of displacement of a sample can be calculated and heat deformation can be calculated by changing temperature and performing each scan (that is, thing for which the temperature of a sample is changed, the scan of the same specification is performed twice or more, and the difference of 2 sets of these data of arbitration is calculated). The approach of measuring the distance between a sample and a displacement gage is desirable by making a sample reflect the laser beam generated with the semiconductor laser generating component as a principle of an optical displacement meter, and detecting the location of the reflected light by the semi-conductor location sensor. And adding the function which displays the amount of displacement of a sample on a display unit to this control unit meets the purpose of this invention.
[0013]
[Function] The heat deformation measuring device by this invention is wearing the top face of a thermostat with a transparence plate, and a displacement gage non-contact [optical] is formed above this transparence plate. The distance between the sample which scanned this displacement gage in the two-dimensional flat surface, and was prepared in the thermostat, and this displacement gage is measured serially, and since it is recordable on the storage in which the measurement result was prepared in this control unit, two-dimensional distribution of ****** deformation of a sample can be searched for with high precision.
[0014] Since a control device performs point to point control of this stage by the digital control method as a means which scans a displacement gage using the screw-thread type stage of a pulse motor drive and the roll control of **** which moreover ****s and cancels the backlash of the screw thread of a formula stage is performed at any time, the positioning accuracy of a displacement gage is high. Furthermore, since a hole is made in the base of a thermostat, the lower limit of through and supporter material is fixed to a surface plate for the supporter material from which coefficient of linear expansion was made from the ingredient 1 ppm [/degree C] or less by this hole and a sample is supported by the upper limit of supporter material, it is not influenced of heat deformation of a thermostat or vibration. Moreover, since the temperature control of a sample is performed by sending into a thermostat the air which carried out the temperature control with the heating cooling system, the heating cooling rate of a sample is quick and temperature distribution are small.
[0015] In the heat deformation measuring device by this invention, since the amount of displacement of a sample is calculated by memorizing the data of the distance between the sample in the scan of the same specification performed twice or more, and this displacement gage to this store, and calculating the difference of 2 sets of these data of arbitration, the heat deformation over the temperature change of arbitration can be searched for easily.
[0016] A sample is made to reflect the laser light generated with the semiconductor laser generating component as a principle of an optical displacement meter. Since the approach of measuring the distance

between a sample and a displacement gage by detecting the location of the reflected light by the semi-conductor location sensor is used, the scan of a displacement gage is suspended in case it is measurement, regularity carries out time amount quiescence and distance between a sample and this displacement gage is measured after that The accuracy of measurement is high and, moreover, data processing is easy. And since the function which displays the amount of displacement of a sample on a display unit is added to this control unit, an operating personnel can understand two-dimensional distribution of a variation rate easily the field of a sample outside.

[0017]

[Example] Hereafter, the example of this invention is explained using a drawing. <> Drawing 1 is the perspective view showing the outline of the example of this invention, and drawing 2 is the sectional view showing the outline of the example of this invention. The thermostat 2 is installed through the support column 10 on the surface plate 9. The top face of a thermostat 2 is covered with the transparence plate 3. Heat-resisting glass is used for the quality of the material of the transparence plate 3. Moreover, the adiabatic efficiency of a thermostat can be raised by making this glass into double glass structure. The hole is made in the base of a thermostat 2 three places, and this hole lets the supporter material 4a, 4b, and 4c pass. The quality of the material of the supporter material 4a, 4b, and 4c needs to use an ingredient with a small coefficient of linear expansion, for example, uses a quartz. The configuration of supporter material has the shape of cylindrical or a pipe.

[0018] The sample installation plate 5 is laid in the upper limit of the supporter material 4a, 4b, and 4c. The sample installation plate 5 also uses a quartz. Furthermore on the sample installation plate 5, the sample 11 is laid. On the surface plate 9, stage 7b for y directional movements is being fixed, and stage 7a for x directional movements is being further fixed on it. The screw-thread type stage of a pulse motor drive is used for these stages. The displacement gage 1 is being fixed to stage 7a through the displacement gage support fixture 6. The displacement gage support fixture 6 is adjusted so that a displacement gage 1 may be located above a sample 11.

[0019] In this example, the sample was made to reflect the visible laser light generated with the semiconductor laser generating component, and the displacement gage by the approach of measuring the distance between a sample and a displacement gage was used by detecting the location of the reflected light by the semi-conductor location sensor. Therefore, since the laser light which hits a sample can be viewed, a measuring point can be known easily. Although duct 8b for exhausting with duct 8a for supplying hot blast to the side face of a thermostat 2 is connected and being omitted by a diagram, duct 8a is connected to the hot blast generator by the heat insulation pipe.

[0020] The arrow head showed the flow of air to drawing 2 . In addition, in drawing 1 and drawing 2 , the electric wiring connected with a displacement gage 1 on Stages 7a and 7b was omitted.

[0021] The control-line Fig. in the example of this invention is shown in drawing 3 . At this example, the control unit consists of a computer, the display, a stage controller, a displacement gage controller, and a temperature controller.

[0022] I/O of data is performed using a computer, and a stage controller, a displacement gage controller, and a temperature controller operate by the command of a computer, and perform control of a stage, a displacement gage, and a hot blast generator, respectively. The data measured with the displacement gage are transmitted to a computer, and are recorded on the storage built in the computer. Suitable data processing is added by computer and measurement data is displayed on a display.

[0023] Drawing 4 is a flow chart which shows actuation of the heat deformation measuring device of this example. A measurement procedure is explained using this drawing below. In this example, in order to measure two-dimensional ****** deformation distribution of a sample, a displacement gage is moved to each lattice point of a rectangle field. Therefore, the time between measurements and the number of point of measurement of x and y both directions are inputted first.

[0024] Next, the laying temperature in a measurement count (count of a temperature step) and each step is inputted. In advance of measurement, a displacement gage is carried out 1 round along the perimeter of a measurement field. A measurement field can be checked when an operating personnel views the laser light from the displacement gage which hit the sample.

[0025] If the measurement field is wrong at this time, it will return first (this function was omitted in drawing 4). Next, measurement is started. First, a displacement gage is moved to the zero of a coordinate and the temperature of a thermostat is controlled to the set point of step 1. if temperature is stabilized -- a displacement gage -- x directions -- every [dx] -- it is made to move After making a displacement gage stand it still, the distance between a sample and a displacement gage is measured, and measured value is

transmitted and recorded on a computer. x directions -- every [dx] -- if Nx time measurement is carried out -- next time -- the direction of y -- dy -- moving -- again -- x directions -- every [dx] -- Nx time measurement is carried out. Only Ny time performs this actuation in the direction of y, and measurement of the temperature step 1 is completed.

[0026] Although omitted in the flow chart, in measuring a variation rate, the hand of cut of **** is surely made the same, and it stops. This is for preventing the positioning-accuracy fall by the backlash of ****. Next, temperature is controlled to the set point of step 2, and same displacement measurement is performed. If measurement is completed to the last temperature step, a Measuring condition and a measurement result will be recorded as one data set.

[0027] The display of a measurement result is performed by making a data set read into a computer. Predetermined data are calculated and the result is displayed on a display. The predetermined operation said here is calculating the difference of the variation rate of the step of arbitration, and the variation rate of other steps, and the heat deformation produced among these steps can be searched for by this operation.

[0028] Since the heat deformation measuring device by this example measures by scanning a displacement gage in a two-dimensional flat surface, it can search for two-dimensional distribution of ****** deformation of a sample with high precision. Since the roll control of **** which moreover ****s and cancels the backlash of the screw thread of a formula stage is performed at any time, using the pulse motor drive **** type stage of a digital control method as a means which scans a displacement gage, the positioning accuracy of a displacement gage is very high.

[0029] Furthermore, since a sample is supported with a direct surface plate through the supporter material made from a quartz with a small coefficient of linear expansion, a sample does not touch a thermostat and is not influenced of heat deformation of a thermostat or vibration. Moreover, since a sample is heated by sending into a thermostat the hot air heated with the hot blast generator, the programming rate of a sample is high and temperature distribution are small.

[0030] Since the approach of measuring the distance between a sample and a displacement gage by making a sample reflect the laser light generated with the semiconductor laser generating component as a principle of an optical displacement meter, and detecting the location of the reflected light by the semi-conductor location sensor is used, the accuracy of measurement is high and, moreover, data processing is easy.

[0031] Furthermore, in the case of measurement, the scan of a displacement gage is suspended, and since time amount quiescence is carried out and distance between a sample and this displacement gage is measured after that, the fixed measurement error by vibration of a displacement gage support fixture etc. can be abolished. And since measurement data is processed by computer and it displays on a display unit, an operating personnel can understand two-dimensional distribution of a variation rate easily the field of a sample outside.

[0032] The example of ****** deformation measurement of the electronic instrument measured with the heat deformation measuring device by this example which the artificer made as an experiment to drawing 5 is shown. It turns out that it is moreover easy to understand the configuration of heat deformation, and it is measured very with high precision.

[0033]

[Effect of the Invention] Since the according to this invention like heat deformation measuring device described above can measure two-dimensional ****** deformation of a body with a sufficient precision simple, it is very helpful for grasping the heat deformation which poses a problem with electronic parts.

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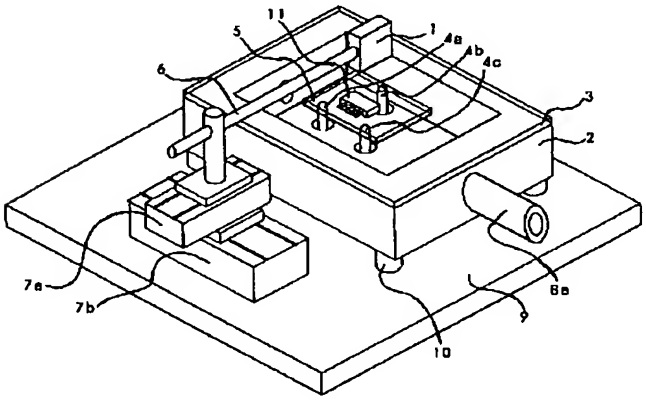
DRAWINGS

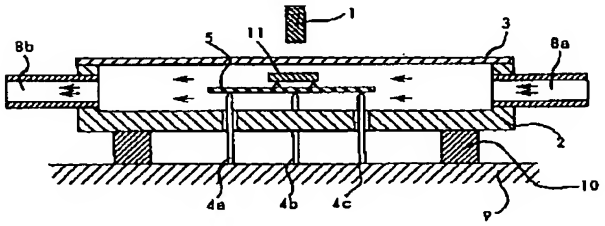
[Drawing 1]

図 1



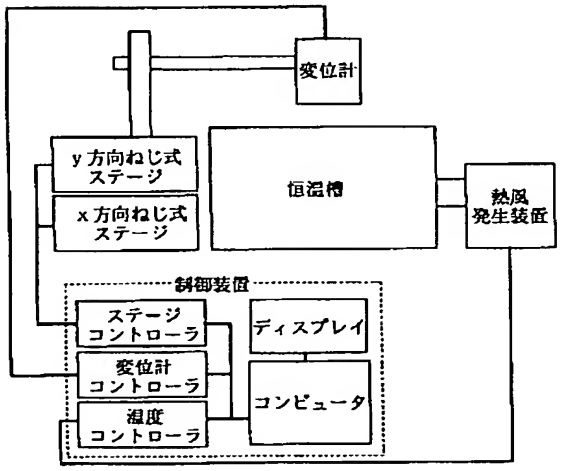
[Drawing 2]

図 2



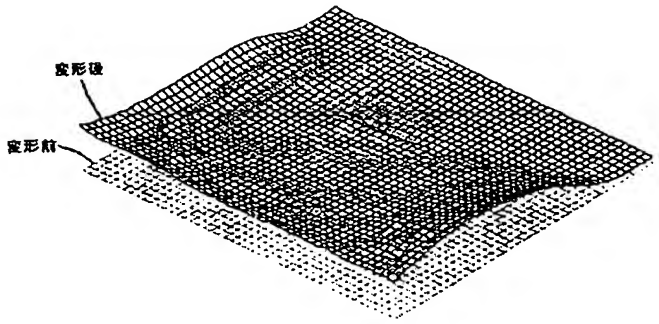
[Drawing 3]

図 3



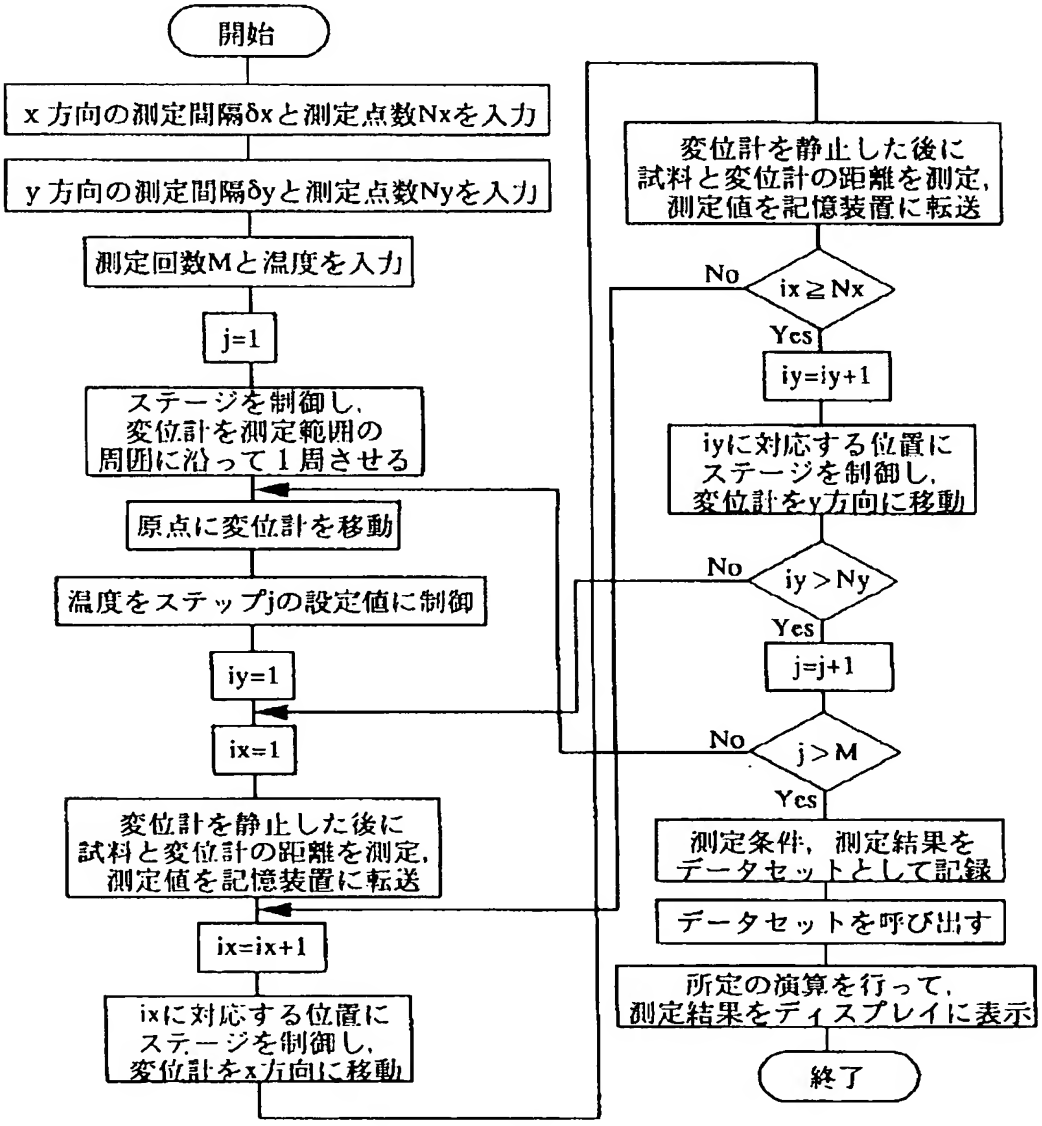
[Drawing 5]

図 5



[Drawing 4]

図 4



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